MCEER
EARTHQUAKE ENGINEERING TO EXTREME EVENTS

BULLETIN

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A Publication of MCEER, Reporting on Center Developments in Earthquake Engineering to Extreme Events

Inside This Issue

MCEER and Calspan Tackle Intelligent Renewal and Improved Resilience of Infrastructure

Partnership to Focus on Full-Scale Testing and Application of Innovative Bridge Technologies

Bridge research at MCEER is rising to a new level through a partnership with Calspan Corporation, an advanced industrial technology center headquartered in Buffalo, NY (see company profile on p. 5). The new partnership will focus the combined talents of both organizations to effectively meet the nation's growing need for the intelligent renewal and improved resilience of its infrastructure from natural-occurring phenomena and extreme events. The first phase of this collaboration will focus on the development, full-scale testing and application of innovative bridge technologies.

Photo: Douglas Levere

On site in Ashford, NY are (from left): UB School of Engineering Dean Harvey Stenger, MCEER Director Andre Filiatrault, Calspan Executive Vice President Thomas Pleban and Principal Investigator George C. Lee.

An aerial view of the 685-acre Calspan facility in Ashford, New York.

The first project will capitalize on Western New York's four seasons to experimentally evaluate the impact of a variety of naturally occurring environmental conditions on seismic isolation systems installed on a bridge. To carry out this experiment, two full-scale single-lane bridges will be built on Calspan's 685-acre Ashford, NY property. Each bridge will be composed of 5 reinforced-concrete box girders that have been donated to MCEER by Hubbell Galvanizing, of Utica, NY. The bridges will include elastomeric seismic isolation bearings, donated by Dynamic Isolation Systems (DIS), of McCarran, NV. The girders were recently moved to the Ashford site, where construction of the 72-foot long bridges will begin this fall.

Experimental testing, scheduled to begin on July 1, 2010 will monitor the

Hubbell Galvanizing of Utica, NY donated the girders for the bridge.

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MCEER Joins Team from Politecnico di Torino to Investigate Damage following the L'Aquila Earthquake

On April 6, 2009 a 6.3 magnitude earthquake struck the central Italian town of L'Aquila, causing almost 300 deaths, about 1,000 injuries, and damage to roughly 15,000 buildings. The earthquake occurred about 60 m east of Rome, along a fault running NW-SE in the central Apennines Mountain range.

On April 15, 2009, Ioannis Christovasilis, a graduate student in the Department of Civil, Structural and Environmental Engineering at the University at Buffalo, visited the stricken region on behalf of MCEER. He was accompanied by Giuseppina Patalano, an engineer from Florence, Italy. He primarily investigated the performance of residential construction on the periphery of the city of L'Aquila, as entry to the city center was generally not allowed at the time of his visit. He provided preliminary damage reports that can be viewed at *http://mceer.buffalo.edu/research/Reconnaissance/LAquila4-06-09/default.asp*.

Team members from the joint Politecnico di Torino and MCEER-University at Buffalo reconnaissance mission; (from left) Gian Paolo Cimellaro, Alessandro De Stefano, Andrei Reinhorn and Tatiana Kirova.

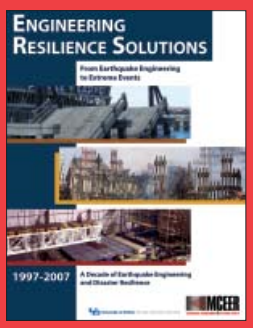
Later in the month of April, MCEER investigators Andrei Reinhorn, Clifford C. Furnas Professor of Structural Engineering, Department of Civil, Structural and Environmental Engineering, University at Buffalo, and Gian Paolo Cimellaro, Assistant Professor, Department of Structural and Geotechnical Engineering, Politecnico di Torino and a graduate of the University at Buffalo's doctoral program in earthquake engineering, joined a team from the Politecnico di Torino to conduct a more extensive survey of damage caused by the earthquake. They focused their attention on damage to infrastructure facilities, particularly electric power, water, hospitals and telecommunications, with a particular interest in the performance of historic palace monuments. They interviewed experts in the area and collected data primarily in the L'Aquila, Paganica, Onna, Castelnuovo and Sulmona areas.

Dr. Cimellaro and Mr. Christovasilis presented the preliminary findings from the reconnaissance visits at a seminar given June 11, 2009 at the University at Buffalo (see review on p. 10). Dr. Cimellaro also presented a seminar on April 15, based on preliminary information gathered prior to the reconnaissance trips. A reconnaissance report is under development and will be published in the near future.

In addition to the reconnaissance mission, MCEER's Information Service created a clearinghouse web page that offers resources and information on the earthquake. Resources include near real-time links to news, images, videos and statistics compiled by Information Service staff members. The page can be viewed at *http://mceer.buffalo.edu/infoservice/disasters/L'Aquila-Earthquake-News.asp*.

Report Showcases Decade of NSF-Sponsored MCEER Research

"Engineering Research Solutions: 1997-2007: A Decade of Earthquake Engineering and Disaster Resilience," showcases MCEER accomplishments during the Center's tenure as a National Science Foundation (NSF) Earthquake Engineering Research Center. These research efforts, built on the solid foundation provided by the National Center for Earthquake Engineering Research (NCEER) during its first 10 years, have advanced knowledge, education, technology and the industrial competitiveness and diversity of the earthquake engineering workforce over the past decade. The full-color, 50-plus page brochure is available at *http://mceer.buffalo.edu*.



New Project Seeks to Extend Resilience Framework

A newly-funded project will expand MCEER's disaster resilience framework to the community level. "A Framework for Defining and Measuring Disaster Resilience at the Community Scale," funded by the National Institute of Standards and Technology (NIST), will build on previous MCEER research linking the four resilience properties (robustness, redundancy, resourcefulness, and rapidity) and resilience dimensions (technical, organizational, societal and economic). The project will develop quantitative and qualitative models to measure the disaster resilience of communities in terms of capital assets such as hospitals and asset classes such as health care facilities. Over the longer term, these models will enable the development of decision-support software tools to help planners, key decision makers and stakeholders enhance the disaster resilience of their communities.

The research effort has three main tasks:

- Conduct a literature survey analyzing asset-based approaches for defining and measuring disaster resilience;
- Identify gaps between asset-based approaches and community scale approaches and develop a conceptual approach to define and measure disaster resilience at the community scale; and
- Publish a technical report that synthesizes findings from the research effort to set the stage for further developments.

Andrei Reinhorn, Department of Civil, Structural and Environmental Engineering (CSEE), University at Buffalo (UB), is the principal investigator of the project. Co-PIs at UB include Chris Renschler, Geography, and Michel Bruneau, CSEE. Lucy Arendt, University of Wisconsin-Green Bay, an expert in social science and policy, and Gian Paolo Cimellaro, Politecnico di Torino, Italy, an expert in systems engineering, will serve as independent consultants.

Earlier this year, a group of MCEER investigators participated in a NIST-sponsored workshop entitled *A Framework for Disaster Resilience*. Held April 13, 2009 at NIST headquarters, the workshop afforded participants from NIST and MCEER with an opportunity to exchange information on the concept of disaster resilience and its applications in earthquake engineering. MCEER Director Andre Filiatrault, former MCEER Director Michel Bruneau, and MCEER investigator Andrei Reinhorn made presentations on a variety of topics related to MCEER's concept of resilience.

More information on MCEER's resilience research can be found at *http://mceer.buffalo.edu/research/resilience/default.asp*.

MCEER-Calspan Partnership

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variation of physical properties of the bearings under changing environmental conditions over a five year period. Buffalo's climate is well-known for its variety in temperature, snow, wind, rain, barometric pressure, etc., which will allow researchers to collect data on how these factors impact the performance and life span of the bearings.

Calspan is designing a dedicated loading system specifically for the experiment. The system will excite the bridge transversely and cause simulated seismic motions of the isolation bearings.

The $750, 000 project is supported by funding from New York State and industry donations. Former MCEER Director and leader of MCEER's Highway Project, George C. Lee, serves as principal investigator of the project.

The MCEER-Calspan partnership leverages the infrastructure-research skills of MCEER, with the testing expertise of Calspan Corporation, internationally recognized for its rich heritage of innovation and proven excellence in technology and science.

More information, including a news release, photos and videos of the site are available at: *http://mceer.buffalo.edu/research/Full-Scale_Bridge_Test/default.asp*.

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NYSATE Conference Focuses on Going Green

George Lee, Keynote Speaker, with Conference General Chairman Tom Markel.

Several MCEER investigators and University at Buffalo faculty participated in the *New York State Association of Transportation Engineers (NYSATE) 69th Annual Conference* in Ellicottville, NY. The event, held June 2-5, 2009, had a theme of "Going Green on the Transportation Scene." About 600 transportation professionals from around the state attended the event, which featured technical sessions, field trips, guest programs and social events.

George Lee, Department of Civil, Structural and Environmental Engineering (CSEE), University at Buffalo, delivered the keynote address, which focused on the various challenges and issues facing today's transportation engineering professionals, and the need for educational programs to prepare future engineers who can more effectively plan, design, construct and maintain sustainable transportation infrastructure systems.

Other CSEE faculty members delivered technical sessions, including Amjad Aref, "Pre-Fabricated Bridge Systems;" Adel Sadek, "Transportation Systems Engineering at the University at Buffalo: Addressing Future Transportation Challenges through Integrative Education and Research;" Stuart Chen, "IT-Streamlined Processes for Bridge Delivery and Life Cycle;" and James Jensen, "Applying Environmental Engineering Principles to Sustainable Transportation: Beyond Hybrids and Tailpipes."

Multi-Hazard Bridge Project Closely Aligned with AASHTO's Strategic Plan for US Bridges

George Lee, principal investigator of MCEER's Federal Highway Administration-funded research project on "Principles of Multiple-Hazard Design for Highway Bridges," updated AASHTO's Technical Committee T-5 on Loads and Load Distribution, on progress to date in the ongoing research project.

In the project, MCEER is critically examining the fundamental approaches used in bridge design today in order to better account for extreme events including potential vehicular or vessel collision, hurricane forces, and wave vulnerability, among others. Harry Capers, Arora Associates, former state bridge engineer from New Jersey, is assisting MCEER by providing end user input and acting as a liaison with appropriate AASHTO technical committees. Dr. Phil Yen is FHWA's contract officer technical representative.

The mid-year meeting, chaired by Sue Hida, Caltrans, included state bridge engineers, and was held on January 22, 2009, in Alexandria, Virginia.

ATC-SEI Conference Opens Early Registration

The challenges to improving the ability of existing buildings and other structures to withstand an earthquake are as broad and varied as the structures themselves. To learn about today's best practices and how to apply them, consider attending *Improving the Seismic Performance of Existing Buildings and Other Structures*, to be held December 9-11, 2009 in San Francisco, California.

Four concurrent tracks of technical sessions will cover topics that include guidelines, standards and analysis improvements; new materials and innovative approaches; mitigation policy issues, strategies, and programs; and case study analysis. In addition, participants can earn up to 18 professional development hours. Beyond the technical study, the conference will include a black-tie gala, over 25 poster displays, and plenary and luncheon addresses by six experts.

The conference is organized by the Applied Technology Council (ATC) and ASCE's Structural Engineering Institute (SEI). MCEER is one of the cooperating organizations. Early registration continues through September 30. For more information, visit *http://www.atc-sei.org/*.

Profile: Calspan Corporation

New Partnership with MCEER to Focus on Infrastructure Renewal

Calspan Corporation was originally founded in 1943 as part of the Research Laboratory of the Curtiss-Wright Airplane Division in Buffalo, NY. Internationally recognized for proven excellence in technology and science, the company has built its reputation on a rich heritage of innovation. Calspan's corporate structure includes five operating units:

- **Crash Data Research Center (CDRC)**: CDRC conducts research on real-world traffic crashes throughout the U.S. The work is conducted under contracts primarily with the Department of Transportation's National Highway Traffic Safety Administration.
- **Flight Research Group (FRG)**: FRG has provided aeronautical services to the domestic and international aerospace community since 1946. It has pioneered the development of in-flight simulation aircraft which enable FRG to provide critical flight control/flying qualities analyses and pilot training services.
- **Systems Engineering Group (SEG)**: SEG provides custom-engineered services and solutions for in-house and customer-based facilities for the aerospace and automotive markets. In addition, it operates an Unmanned Vehicle Proving Ground, ballistics/ordnance test ranges, altitude chambers, and a machine shop.
- **Transonic Wind Tunnel (TWT)**: Calspan's TWT is the largest independent test facility of its kind in the U.S., providing quick-response and impartial customer-oriented services since 1947. Continuously serving the aerospace community, the TWT has accumulated over 140,000 hours of testing.
- **Transportation Research Group (TRG)**: TRG is the leader in high-quality, independent automotive safety testing, research, development, and evaluation using state-of-the art facilities since 1948. TSC also provides custom-engineered test facilities to automotive manufacturers worldwide.

Calspan Corporation has approximately 240 employees with a variety of talents and backgrounds. A key element in the company's success is its interdisciplinary approach. Calspan's highly integrated work force includes mechanical, electrical, computer system, software, control system and aeronautical engineers; test pilots; and aircraft and test facility electronic technicians and mechanics. The company has served as an incubator for numerous Western New York companies. Its main complex is located at 4455 Genesee St. in Cheektowaga, NY. For more information about Calspan, visit *http://www.calspan.com*.

For more information on partnering opportunities with MCEER, contact Don Goralski at (716) 645-5151 or goralski@buffalo.edu

Thybar Joins Strategic Partnerships Network

Thybar Corporation, a custom product manufacturer serving the HVAC and sheet metal industries for more than 50 years, is the newest Flagship member of MCEER's Strategic Partnerships Network. Thybar's patented roof curbs, including Vibro-Curb® for vibration isolation applications, and Retro-Mate®, which is custom fabricated to adapt existing curbs to fit new rooftop equipment, make Thybar a leader in the field as more stringent requirements for attaching mechanical equipment to rooftops have been added to building codes and regulations. The company is based in Addison, Illinois, and has plants in Dallas, Akron, Louisville, and Reno to serve regional requirements of its customers. For more information about Thybar, please visit *http://www.thybar.com/*.

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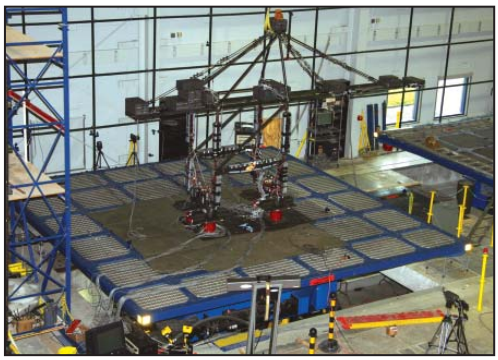
UB-NEES Recognized for Outstanding Research Service



Crane structure on the shake table at UB-NEES.

UB-NEES received an *Outstanding Service to Researchers Honorable Mention Award* for exceptional support on the NEES Grand Challenge entitled "Seismic Risk Mitigation for Port Systems." The award, which is given to a NEES Site in recognition of research support services that greatly exceeded expectations, was presented at the NEES Annual Meeting, held June 23-25, 2009 in Honolulu, Hawaii. The PI of the project, Glenn Rix, a Professor in the School of Civil and Environmental Engineering at Georgia Tech, nominated the UB team for its outstanding support of the experimental portion of the seismic performance of cranes project.

UB-NEES team members are Mark Pitman, Structural Engineering and Earthquake Simulation Laboratory (SEESL) Technical Services Manager; Thomas M. Albrechcinski, NEES Site Operations Manager; Goran Josipovic, NEES Information Technology Manager; Scot Weinreber, Senior Electronic/Instrumentation Engineer; Myrto Anagnostopoulou, Senior Structural Engineer; Christopher Budden and Christopher Zwierlein, Electronic/Instrumentation Specialists; Duane Kozlowski, Field Safety Officer and Lead Mechanical Technician (Machine Operations); Lou Moretta, Robert Staniszewski and Jeffrey Cizdziel, Welding and Steel Construction; and Carmela Gosden, Senior Administrative Assistant.

Visit *http://nees.buffalo.edu/projects/NEESPorts/* for more information on the research project, *http://www.nees.org/* for information on the NEES Consortium and *http://seesl.buffalo.edu/* for more information on SEESL.

TCLEE Conference Focuses on Multiple Hazards

The 2009 TCLEE Conference, *Lifeline Earthquake Engineering in a Multihazard Environment,* featured the contributions of many MCEER investigators, both past and present. MCEER Director Andre Filiatrault served on the conference Steering Committee, and former MCEER highway project investigator Stu Werner was the Conference Chair.

Professor Tom O'Rourke, Cornell University, delivered the opening plenary session address, "Lifeline Performance Under Extreme Events," showcasing much of his MCEER-funded research on the impact of a wide variety of hazards on water distribution, electric power, oil and gas delivery, transportation and telecommunications systems. MCEER was a Bronze-level sponsor of the conference and hosted an exhibit, which was manned by Donald Goralski, MCEER Chief of Staff.

The conference was held June 28-July 1, 2009 in Oakland California. For more information, visit *http://content.asce.org/conferences/tclee2009/*.

Foreign Trade Mission Delegates Visit SEESL

On April 30, 2009, over 70 delegates from 35 countries visited UB's Structural Engineering and Earthquake Simulation Laboratory (SEESL) as part of a foreign trade mission to the Western New York area to learn more about market-based opportunities for investment. The group was hosted by New York State Governor David A. Paterson and the Empire State Development Corporation, and spent two days visiting various businesses and organizations in the area. SEESL and MCEER Director Andre Filiatrault provided an overview of the UB-NEES testing capabilities and research programs. Tom Albrechcinski, the UB-NEES Site Operations Manager, coordinated the visit and organized the tour.

Andre Filiatrault describes the research capabilities of SEESL to foreign trade mission delegates.

New Faculty Featured at UB Extreme Events Mixer

Opportunities for collaboration were among the aims of the Mixer.

On March 26, 2009, 32 faculty members and five graduate students with research interests in the UB 2020 Strategic Strength on Extreme Events: Mitigation and Response gathered for the *Spring 2009 Extreme Events Faculty Mixer*, held at UB's Center for the Arts. The event had two main purposes: introduce new faculty hires at the University at Buffalo in Extreme Events, and allow faculty from many different departments and schools at UB to meet and find opportunities for collaboration.

A. Scott Weber, Chair of the Department of Civil, Structural and Environmental Engineering (CSEE), welcomed the participants. New faculty then presented their research interests. Presentations were made by

Small group discussions focused on research topics, research processes and potential funding sources.

Lisa Butler, Social Work; Beata Csatho, Geology; JiYoung Park, Urban and Regional Planning; Pavani Ram, Social and Preventive Medicine; Adel Sadek, CSEE; Greg Valentine, Geology; Bob Viswanathan, Operations Management and Strategy; Qian Wang, CSEE and Jun Zhuang, Industrial and Systems Engineering. MCEER Director Andre Filiatrault followed with "The Future Vision of MCEER-CSEE."

The presentations were followed by two rounds of small group discussions, one on research topics, and the other on research process and funding.

The organizing committee for the event included Harvey Stenger, Dean, School of Engineering & Applied Sciences and Acting Chair, Extreme Events Faculty Advisory Committee; Ernest Sternberg, Urban & Regional Planning; Steven Dubovsky, Psychiatry, and Adel Sadek, CSEE.

More information is available on the UB 2020 Extreme Events website at *http://mceer.buffalo.edu/ub2020/default.asp.*

SUNY's New Chancellor Visits MCEER

SUNY Chancellor Nancy Zimpher included a brief visit to MCEER on June 24, 2009 as part of her tour of the University at Buffalo and other SUNY campuses around the state. Harvey Stenger, Dean, School of Engineering & Applied Sciences, A. Scott Weber, Professor and Chair of the Department of Civil, Structural and Environmental Engineering, and MCEER's Donald Goralski, Chief of Staff, hosted her visit and tour of UB's Structural Engineering and Earthquake Simulation Laboratory (SEESL). Chancellor Zimpher is a strong supporter of the University at Buffalo's UB 2020 Flexibility and Economic Growth Act, a bill which could save New York State taxpayers millions of dollars, while providing a predictable stream of revenue to better enable the University at Buffalo to provide students with financial needs with access to a high-quality education. The bill has been approved by the NYS Senate and is under consideration by the Assembly. For more information on UB 2020, visit *http://www.buffalo.edu/ub2020/overview/.*

Photo: Nancy J. Parisi

A. Scott Weber (left), Nancy Zimpher (center) and Donald Goralski (far right) in the Structural Engineering and Earthquake Simulation Laboratory during a tour of MCEER.

Interdisciplinary Transportation Systems Program

A new program in transportation systems is being offered this fall at the University at Buffalo in conjunction with UB 2020's Strategic Strength on Extreme Events. Prompted by the addition of Adel Sadek and Qian Wang to the Department of Civil, Structural and Environmental Engineering (CSEE) faculty, the program builds upon a long tradition of transportation research at UB, and includes coursework and faculty from a variety of departments and schools as well as nationally recognized centers and programs across the campus. For more information, contact Dr. Sadek, *asadek@buffalo.edu* or Dr. Wang, *qw6@buffalo.edu.*

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"Planet Quake" Introduces High School Students to Careers in Engineering

Seventy Western New York high school students participated in the BEAM (Buffalo-area Engineering Awareness for Minorities) program's Star Trek-themed competition. The all day event on Saturday, May 23, 2009, was a test for the students to prove their scientific and mathematical mettle in a brain-teasing race around the campus. Not knowing what to expect, students had to locate the venues based on Trekie clues and complete various engineering tasks in order to move-on to the next venue.

The "Planet Quake" activity combined engineering and structural design skills and required students to build a landing structure and platform, and during a simulated seismic event, successfully land a mini-Starship Enterprise. The landing structures were tested

The "Planet Quake" activity required high schoolers to land a mini-Starship Enterprise during an earthquake on a platform they designed.

on a portable shake table that replicated actual seismic events, including the 1994 6.7 magnitude Northridge, California earthquake.

The task was designed, developed and led by UB-NEES Site Operations Manager Tom Albrechcinski with the support of Gilberto Mosqueda, Assistant Professor, Department of Civil, Structural and Environmental Engineering, and Sofia Tangalos, Manager of MCEER's Information Service. The Planet Quake Flight Test officers were assisted by seven CSEE graduate students during the day of the event.

UB's BEAM is a cooperative educational enrichment program that prepares inner-city, minority, female and other under-represented students for careers in science, engineering and technology through after-school and summer programs. BEAM encourages, recruits and retains women and minorities to the engineering professions. The BEAM Trek event was the result of efforts by dedicated alumni of the UB School of Engineering and Applied Sciences working with local companies and educational organizations to find new sources of support. Over $20,000 was raised for summer educational programs.

Earthquakes Featured in Discovery Camp's Unseen World

Andrew McNeil, of MCEER's Information Service, participated in the Buffalo Museum of Science Summer Discovery Camp on July 6, 2009. He spoke with a group of students on topics ranging from basic geophysical elements of earthquake propagation, potential dangers from seismic events, and physical characteristics of the liquefaction phenomenon.

Students tested models they built on a shake table at the Discovery Camp.

The Discovery Camps are week long educational experiences focused on central themes. The students ranged from 9-12 years old and were engaged in an exploration of the theme of the week, the *Unseen World*. The students had recently completed construction of individual, simple structures that they intended to test for seismic performance on a basic shake table.

In keeping with the Camp's theme, Mr. McNeil also performed a physical demonstration on the properties of liquefaction generation and fielded questions from the eager students on varied topics including the safest way to design a house and where the most devastating earthquake in the world occurred.

For more information, visit the Buffalo Museum of Science website at *http://www.sciencebuff.org/* and the Discovery Camps website at *http://www.sciencebuff.org/programs/public-programs/discovery-camps/*. See the MCEER Information Service write up at *http://mceer.buffalo.edu/infoservice/Education/BMS.asp*.

UB Team Shakes it up in Salt Lake City

A team of undergraduates from the University at Buffalo competed in the *Sixth Annual Undergraduate Seismic Design Competition*. The team was one of eighteen to participate in the yearly competition, which was held at the Earthquake Engineering Research Institute's (EERI) *Annual Meeting* on February 11-14, 2009.

The UB team of David Hastings, captain, Nick Montaldi, Kyle Duck, Claude Semexant, Ethan Gew, Chih Kai Chang, Zoran Umicevic and Richard Skomra traveled to Salt Lake City, Utah, bringing the balsa wood commercial office building they designed and built for the event. Lenore Dunnah, Ha Nool Oh and Wai Lun Tsang also participated in the design and construction of the model.

During the competition, the model was tested on a shake table to ground motions simulating the 1940 El Centro, 1994 Northridge and 1995 Kobe earthquakes. Structures were built to maximize floor space for tenants while minimizing seismic damage, and were evaluated based on architectural design, structural innovation and financial return for the client over the life of the structure. Additional points were awarded for the teams' posters and power point presentations.

The competition was sponsored by EERI, the Department of Homeland Security, the Federal Emergency Management Agency, Computers & Structures, Inc., Degenkolb and Digitexx. Cal Poly San Louis Obispo won this year's contest, with Brigham Young University placing second, and Oregon State University third.

The UB team was one of eighteen to compete at this year's undergraduate seismic design competition.

More on this event and the previous undergraduate seismic design competitions is available at *http://mceer.buffalo.edu/education/usdc/*.

The UB team poses with the balsa wood office building they designed and built for the competition.

Student Spotlight: Petros Sideris

Student Spotlight

Petros visited the Summer Palace in Beijing, China during the 14th World Conference on Earthquake Engineering

Ph.D. candidate Petros Sideris likes the challenge of coming up with feasible solutions to practical and theoretical problems. His research, conducted under the supervision of Professors Andre Filiatrault and Amjad Aref in the University at Buffalo's Department of Civil, Structural and Environmental Engineering (CSEE), allows him to do both. In his current research project, "Analytical and Experimental Investigation of the Dynamic Behavior of Precast Segmental Bridges Under Earthquake Excitation," he is formulating flexibility-based macro-elements capable of capturing key characteristics of the dynamic response of segmental systems. These elements could provide significant insight into the response of such systems under strong earthquake shaking.

On the practical side, he is participating in the design and execution of a shake table experiment planned for Spring 2010 on a large scale single span segmental concrete bridge. For his Master's Thesis, he worked on a study (under Andre Filiatrault) that introduced inclined shelving as a measure for reducing seismic hazards in warehouses due to falling rack contents.

A native of Greece, Petros was always aware of the devastation a strong earthquake can cause. During his undergraduate studies at the National Technical University of Athens, he discovered that the challenges of earthquake engineering spur him to progress. He also realized "the significance of earthquake-resistant systems to the well-being of society."

Petros, who won a fellowship for the 2007-2008 academic year, expects to receive his Ph.D. in 2010 and plans to remain active in the field of earthquake engineering after he graduates. He is currently the president of the CSEE's Graduate Student Association and treasurer of the UB-EERI Student Chapter.

In his free time, Petros leads the Hellenic Dance Group, which participates in the International Education Week Event at UB.

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Seminar Series

The EERI student chapter of the University at Buffalo (UB-EERI), the MCEER Student Leadership Council, the Networking and Education Programs of MCEER, and the University at Buffalo's Department of Civil, Structural and Environmental Engineering jointly sponsor a series of seminars on a variety of topics related to earthquake hazard mitigation. The purpose of the seminar series is to widen accessibility to timely, technical presentations by students, researchers, visitors and affiliates of MCEER. All seminars are held at the University at Buffalo, and most are broadcast over the Internet in real-time. They can be viewed on the MCEER website at *http://mceer.buffalo.edu/education/webcast/default.asp*.

Field Reconnaissance following the April 6, 2009 L`Aquila Earthquake in Italy

Gian Paolo Cimellaro, Assistant Professor, Department of Structural and Geotechnical Engineering at Polytechnic University of Turin (Politecnico di Torino), and Ioannis Christovasilis, Graduate Student, Department of Civil, Structural and Environmental Engineering, University at Buffalo, June 11, 2009

The presentation detailed the preliminary reconnaissance findings of MCEER team members from UB's Department of Civil, Structural and Environmental Engineering who visited the earthquake stricken area. Ioannis Christovasilis, a graduate student, traveled to the region within a week of April 6, 2009. Later that month, Andrei Reinhorn, Professor, and Gian Paolo Cimellaro, Visiting Professor, joined a team from the Polytechnic University of Turin (Politecnico di Torino) that focused on infrastructure facilities, particularly electric power, water, hospitals and telecommunications. The majority of the damage occurred in the medieval city of L'Aquila (capital city of the Abruzzo region) and its surrounding villages. For example, the 13th century Basilica di Santa Maria di Collemaggio collapsed from the transept to the back of the church. The third floor of Forte Spagnolo, the 16th century castle housing the National Museum of Abruzzo, collapsed, as did the cupola of the 18th century Baroque church of St Augustine, damaging L'Aquila's state archives. The City Hall (Palazzo Margherita, XIII sec.) and its civic tower were damaged as well as the Palace of the National Library. The apse of the Basilica of Saint Bernardino of Siena, L'Aquila's largest Renaissance church, was seriously damaged, and its campanile collapsed. Almost the entire dome of the 18th century church of Anime Sante in Piazza Duomo fell down. Damage to new buildings in the area of Pettino and at the Hospital San Salvatore was also observed. A PDF of Dr. Cimellaro's presentation is available from MCEER at *http://mceer.buffalo.edu/research/Reconnaissance/LAquila4-06-09/default.asp*.

L`Aquila Earthquake in Italy

Gian Paolo Cimellaro, Assistant Professor, Department of Structural and Geotechnical Engineering at Polytechnic University of Turin (Politecnico di Torino), April 15, 2009

Dr. Cimellaro's presentation gave an overview of the M6.3 earthquake that struck L'Aquila Italy on April 6, 2009, killing 294 people and leaving approximately 29,000 people homeless. Topics included geology at the site of L'Aquila, seismic zonation, emergency response, damage to recently constructed buildings (masonry and RC), damage to critical facilities and damage to historic monuments, including the 13th century Basilica di Santa Maria di Collemaggio, which was seriously damaged in the quake. A PDF of the presentation is available from MCEER at *http://mceer.buffalo.edu/research/Reconnaissance/LAquila4-06-09/default.asp*.

Infrastructure – Economic Stimulus Possibilities: Barriers Removed Allow Engineering and Construction "Miracles"

Reinhard Ludke, S.E., Vice President, Creegan & D'Angelo Infrastructure Engineers; President, Structural Engineers Association of Northern California, March 20, 2009

Reinhard Ludke's presentation described how structural engineers and contractors constructed the 580 Maze Disaster freeway ramp in only twenty-five days after a gasoline tanker crash caused the bridge structure to collapse. Experts predicted 100 days or more of freeway closures and detours. The "miracle" occurred when seven disaster response components – a Disaster Response Plan, Emergency Declaration by the Governor, Support and Commitment by Local, State and Federal Government, Eliminate Barriers to success, Dedicated Structural Engineers, Financial Incentives and a Qualified Experienced Contractor - all came together, under committed leadership.

MCEER Movers & Shakers

Fathali and Filiatrault Receive ASHRAE Transactions Paper Award


Saaed Fathali


Andre Filiatrault

Saeed Fathali and Andre Filiatrault received a 2008 ASHRAE Transactions Paper Award for their paper, "Experimental Seismic Performance Evaluation of Integrated Isolation/Restraint Systems for Heavy HVAC Equipment." The paper appeared in Vol. 114, Part I of ASHRAE Transactions. Saeed Fathali received his Ph.D. from the Department of Civil, Structural and Environmental Engineering at the University at Buffalo in 2008. He is now a design engineer with Rutherford & Chekene, Structural and Geotechnical Engineers in Lafayette, California. Andre Filiatrault is a professor in the Department of Civil, Structural and Environmental Engineering and MCEER Director, University of Buffalo. The award was presented at the ASHRAE Annual Conference in Louisville, Kentucky on June 21, 2009.

Mosqueda Receives Young Investigator Award


Gilberto Mosqueda

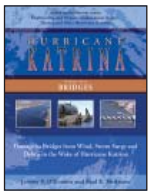
Gilberto Mosqueda, Assistant Professor, Department of Civil, Structural and Environmental Engineering, received a 2008 Young Investigator Award from the University at Buffalo. The Young Investigator Award is one of UB's Exceptional Scholar Awards, given to untenured faculty members who have received their Ph.D's within the last eight years and who have garnered accolades beyond the norm in their fields. Mosqueda received the award at a joint reception for winners of 2008 and 2009 awards.

Staff News


Michelle Zuppa

MCEER staff bid a fond farewell to Michelle Zuppa, our Media Production Specialist and Webmaster. Michelle joined MCEER in 2000, and since then, has made her mark on hundreds of MCEER publications, including this newsletter. She has also done an excellent job of keeping our vast website organized and up to date. She is leaving MCEER to pursue graduate studies in creative writing at Bowling Green State University in Ohio. We wish her all the best in her academic pursuits and will miss her cheerful personality and cooperative spirit.

Hurricane Katrina Report Examines Damage to Bridges



Damage to Bridges from Wind, Storm Surge and Debris in the Wake of Hurricane Katrina by Jerome S. O'Connor and Paul E. McAnany, focuses on the structural performance of bridges based on findings from reconnaissance trips to the coast of Mississippi and adjoining areas of Louisiana and Alabama. The first investigation took place September 6-11, 2005, about a week after the event, with the second following a month later, in October 2005.

The report includes an overview based on an aerial reconnaissance flight over the Mississippi coast, and provides a photographic essay documenting conditions at a variety of sites throughout the area.

The most severe damage was found near Biloxi Bay, St. Louis Bay, and Lake Pontchartrain. Katrina's intensity lifted water levels to unprecedented elevations, which created a scenario that was not envisioned when the bridges were designed and built. Structural failures resulted primarily from wave forces and debris hitting bridges.

The report, MCEER-08-SP05, is the fifth and final volume in the Hurricane Katrina report series. It can be ordered online for $35.00. Screen quality versions of the Hurricane Katrina reports are available at *http://mceer.buffalo.edu/publications/Katrina/default.asp.*

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New Technical Reports

Fragility Analysis of Water Supply Systems

By A. Jacobson and M. Grigoriu, MCEER-08-0009, March 10, 2008, 154 pages, $25.00

This report describes a procedure to assess the seismic performance of water supply systems. Seismic hazard models were developed to generate earthquake activity at single and multiple sites. Methodologies to obtain the fragility of a given pipeline were developed, including several hazard conditions: continuous and jointed pipelines subjected to seismic waves, pipelines subjected to PGD hazards, and pipelines subjected to fault displacements. Information was integrated into an algorithm that used Monte Carlo simulation to determine the damage states of individual components, and hydraulic analyses to estimate the performance of the damaged system. The algorithm was applied to a sample water supply system, and fragility curves were produced under different limit states. In addition, a procedure to estimate the life cycle damage and cost over the life span of the system was presented.

Experimental Investigation of Full-Scale Two-Story Steel Plate Shear Walls with Reduced Beam Section Connections

B. Qu, M. Bruneau, C.-H. Lin and K.-C. Tsai, MCEER-08-0010, March 17, 2008, 196 pages, $30.00

This report describes an experimental research program on Steel Plate Shear Walls (SPSWs), conducted in collaboration with the National Center for Research on Earthquake Engineering (NCREE) in Taipei, Taiwan. The research project investigated the replaceability of infill panels following an earthquake, the behavior of a repaired SPSW in a subsequent earthquake, and the seismic performance of intermediate beams. The test specimen was a two-story SPSW that had an intermediate composite beam with reduced beam section (RBS) connections. In Phase I, the specimen was pseudodynamically tested and subjected to three ground motions of progressively decreasing intensity. The buckled panels were replaced by new panels prior to subjecting the specimen to a subsequent pseudodynamic test and cyclic test to failure in Phase II. The results showed that replacing the buckled infill panels was a viable option that would provide adequate resistance against future earthquakes.

Seismic Evaluation and Rehabilitation of Critical Components of Electrical Power Systems

By S. Ersoy, B. Feizi, A. Ashrafi and M. A. Saadeghvaziri, MCEER-08-0011, March 17, 2008, 286 pages, $35.00

The goal of this study was to assess the seismic performance of electrical power substations and develop rehabilitation measures for existing substations using advanced technologies. A comprehensive study was conducted that included detailed finite element analyses of different types of transformers and bushings, as well as parameter and experimental studies of the friction pendulum system for use as a possible mitigation approach. Simplified models were developed and interaction among transformer-bushing and interconnecting equipment was investigated. Internal packaging of transformers was evaluated and its seismic performance was qualitatively assessed. Experimental studies of critical substation components were performed in collaboration with the National Center for Research on Earthquake Engineering (NCREE) in Taiwan. The results demonstrate that base isolation using a friction pendulum system is a viable rehabilitation option for substations.

Seismic Behavior and Design of Boundary Frame Members of Steel Plate Shear Walls

By B. Qu and M. Bruneau, MCEER-08-0012, April 26, 2008, 276 pages, $35.00

This report presents the results of an analytical study to investigate the behavior of horizontal and vertical boundary frame members that may impact the performance of Steel Plate Shear Walls (SPSWs). New analytical models were developed for horizontal boundary frame members to calculate the plastic moment and resulting strength reduction caused by biaxial internal stress conditions, and to revisit and develop improved capacity design procedures that account for them. The models incorporate observations made in a companion experimental study (see Technical Report MCEER-08-0010). Next, the adequacy of a flexibility limit for the design of vertical boundary frame members specified in current design codes was assessed using the new models. The contribution of the boundary frame moment resisting action and infill panel tension field action to the overall plastic strength of SPSWs was investigated.

Development and Appraisal of a Numerical Cyclic Loading Protocol for Quantifying Building System Performance

By A. Filiatrault,, A. Wanitkorkul and M. Constantinou, MCEER-08-0013, April 27, 2008, 142 pages, $25.00

The objective of this study was to develop a numerical cyclic loading protocol, based on available experimental and numerical studies, to quantify building system performance. The report reviews and compares existing experimental loading protocols

that have been developed for quasi-static cyclic testing of structural components and systems. A numerical cyclic loading protocol is then proposed for quantifying building system performance. Next, a sensitivity analysis of the influence of the number of repeating cycles of the proposed numerical cyclic loading protocol on the equivalent elastic lateral stiffness and viscous damping properties of a 4-story reinforced concrete building model is investigated. Based on the results, the proposed numerical cyclic loading protocol is used in a simplified capacity spectrum methodology to estimate the seismic response of two 4-story and one 12-story building models.

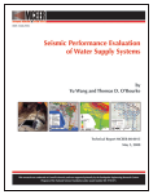
Structural and Nonstructural Earthquake Design: The Challenge of Integrating Specialty Areas in Designing Complex, Critical Facilities

By W.J. Petak and D.J. Alesch, MCEER-08-0014, April 30, 2008, 74 pages, $25.00

This report explores the challenges faced by engineers and architects in integrating structural and nonstructural elements in the design of earthquake resistant buildings. The authors review the traditional roles and responsibilities of various participants in constructing a modern building, and explore impediments to incorporating nonstructural design into engineering practice. Several possible solutions are proposed, including the creation of a new profession called a "master builder" who would serve as a building systems integrator. Legislation such as California's SB 1953, which brought the problems associated with integrating architecture, structural engineering, and the design and installation of nonstructural components of acute care hospitals into sharp focus, may provide some incentive to academic institutions to broaden current curriculums to be more in line with the needs of professional practice in this area.

Seismic Performance Evaluation of Water Supply Systems

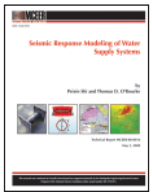
By Y. Wang and T.D. O'Rourke, MCEER-08-0015, May 5, 2008, 398 pages, $35.00



This report describes an evaluation process for simulating the seismic performance of large geographically distributed water supply systems and characterizing their performance in terms of reliability and serviceability. The evaluation process uses probabilistic seismic hazard analysis tools, theoretical and empirical relationships of pipeline responses, hydraulic analysis of heavily damaged water networks, and multi-scale simulations of complex water systems. The process provides information for decision makers to assess the economic and social impacts of lifeline disruptions due to earthquakes, and works in combination with a computer code, Graphical Iterative Response Analysis for Flow Following Earthquakes (GIRAFFE) developed by the authors to simulate heavily damaged pipeline networks. The simulation results are presented in GIS format. The methodology was used to evaluate the seismic performance of the Los Angeles Department of Water and Power (LADWP) water supply system. The results show that the five water districts in the LADWP have significantly different seismic risks and deteriorate to various extents after a 24-hour period following an earthquake. These differences are consistent with the geographical position of the districts in relationship to the faults and their capacity for water storage.

Seismic Response Modeling of Water Supply Systems

By P. Shi and T.D. O'Rourke, MCEER-08-0016, May 5, 2008, 352 pages, $35.00



This report presents a comprehensive model for simulating the earthquake performance of water supply systems. The model is developed in conjunction with the water system operated by the Los Angeles Department of Water and Power (LADWP) and validated through comparisons to observations and flow measurements following the 1994 Northridge earthquake. The performance of damaged water supply systems is simulated by a hydraulic network analysis that uses an iterative approach to isolate the network nodes with negative pressures. The isolation process accurately accounts for flows and pressures in the damaged water networks. The seismic performance of the LADWP system is simulated using a multiscale technique in which the LADWP trunk system is explicitly accounted for, while the remaining distribution lines are simulated through fragility curves relating demand to repair rate. The repair rate, in turn, is correlated with peak ground velocities, and fragility curves are developed on the basis of distribution network simulations. The proposed model is integrated into computer code, Graphical Iterative Response Analysis for Flow Following Earthquakes (GIRAFFE) developed by the authors, which presents the simulation results in GIS format.

Numerical and Experimental Studies of Self-Centering Post-Tensioned Steel Frames

By D. Wang and A. Filiatrault, MCEER-08-0017, May 12, 2008, 436 pages, $60.00

This report presents a numerical and experimental study to evaluate and compare the seismic performance of Self-Centering Post-Tensioned (SCPT) steel frames and conventional Steel Moment Resisting Frames (SMRF). A methodology for designing SCPT structures is developed and used to retrofit an existing four-story SMRF medical facility located in Northridge, California. A Relative Performance Index (RPI) is proposed to compare the enhancement in the seismic response of SCPT's to the SMRF's. Numerical simulations and shake table tests were carried

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out on two scaled 3-story 2-bay SCPT and SMRF building prototypes based on the medical facility. The study indicates that the seismic floor displacements of SCPT and SMRF are alike, while absolute floor accelerations are lower when self centering systems are implemented. Moreover, while yielding in the beam-to-column connections of the SMRF are observed, only yielding of the sacrificial devices in the self centering system of the SCPT occurred during the strongest ground motions considered.

Development, Implementation and Verification of Dynamic Analysis Models for Multi-Spherical Sliding Bearings

By D.M. Fenz and M.C. Constantinou, MCEER-08-0018, 8/15/2008, 308 pages, $35.00

This report describes the formulation, implementation and validation of multi-spherical sliding bearing models proposed for response history analysis of double and triple Friction Pendulum (FP) bearings. These bearings exhibit hysteretic behavior that is more complex than current seismic isolation devices. Since double FP bearings behave like two single concave FP bearings connected in series, the proposed model considers a series arrangement of single FP elements. Additionally, it is shown that a series arrangement can be used to capture the behavior of triple FP bearings provided that the model parameters are appropriately modified. The proposed models can be implemented in currently available structural analysis programs such as SAP2000 and 3D-BASIS. The FP bearing models presented in this report are verified by comparing the results obtained from shake table testing of a quarter-scale six-story building model to those predicted by response history analysis. Good agreement is observed even in cases of extreme response, which attest to the robustness and validity of the proposed models.

Performance Assessment of Conventional and Base-Isolated Nuclear Power Plants for Earthquake and Blast Loadings

By Y-N Huang, A.S. Whittaker and N.Luco, MCEER-08-0019, October 28, 2008, 400 pages, $35.00

This study assesses the performance of conventional and base isolated Nuclear Power Plant (NPP) reactor buildings subjected to earthquake and blast loadings. Three base isolation systems, friction pendulum, lead-rubber and low damping rubber bearings, are studied. A new procedure for probabilistic seismic risk assessment of structures is proposed, built on the methodology presented in the ATC-58 Guidelines and the Zion method. The seismic performance assessment confirms the ability of base isolation systems to reduce spectral demands on secondary systems. Response-history analyses of conventional and base isolated reactor buildings to external blast loads are performed. The spectral demands on the secondary systems in the base isolated reactor building due to air blast loadings are greater than for a conventional reactor building, but much smaller than the demands associated with the safe shutdown earthquake loading. The base isolation systems are shown to be effective at filtering out high acceleration-high frequency ground shock loading.

Building Inventory Compilation for Disaster Management: Application of Remote Sensing and Statistical Modeling

By P.Sarabandi, A.S. Kiremidjian, R.T. Eguchi and B.J. Adams, MCEER-08-0025, November 20, 2008, 132 pages, $25.00

This report introduces a methodology to extract spatial, geometric and engineering attributes of buildings using single high-resolution satellite images. Rational Polynomial Coefficients (RPC) are used to generate three dimensional models of buildings showing height, footprint, and shape information. Geometric information defining the sensor's orientation is used in conjunction with the RPC projection model to generate digital elevation models. The report describes how the location and height of a structure are extracted by measuring the image coordinates for the corner of a building at ground level and its corresponding roof-point coordinates, and using the relationship between image-space and object-space together with the sensor's orientation. The implementation of the algorithm and its application to the City of London are described. In addition, a methodology based on a multinomial logistic model is developed to infer the marginal probability distributions of the structural type and occupancy of a building. Datasets collected for southern California are used to train the models and establish inference rules to predict the engineering parameters of the buildings in the region. The predictive capability of the model is shown through the computation of the marginal probability distribution for a sample building.

New Experimental Capabilities and Loading Protocols for Seismic Qualification and Fragility Assessment of Nonstructural Systems

By R. Retamales, G. Mosqueda, A. Filiatrault and A. Reinhorn, MCEER-08-0026, November 24, 2008, 354 pages, $35.00

This report describes the new experimental testing capabilities provided by the University at Buffalo Nonstructural Component Simulator (UB-NCS). The UB-NCS is composed of a two-level testing frame that can subject full-scale nonstructural components and systems to 3g acceleration, 100 in/s (250 m/s) velocity and ±40 in

(±1 m) displacement amplitudes. An innovative set of testing protocols utilizing the UB-NCS capabilities is described for qualification testing and fragility assessment. The protocols complement, and in some cases extend, the capabilities of current protocols such as AC156 and FEMA 461. The UB-NCS testing capabilities are demonstrated through a series of experiments assessing the seismic performance of a full-scale composite hospital emergency room containing typical nonstructural components such as architectural finishes, piping systems and medical equipment. The seismic performance of individual components were evaluated as well as the dynamic interactions between them. The input motions included the proposed loading protocol and simulated building floor motions.

Effects of Heating and Load History on the Behavior of Lead-Rubber Bearings

By, Ioannis V. Kalpakidis and Michael C. Constantinou, MCEER-08-0027, December 1, 2008, 290 pages, $35.00

This report presents a comprehensive investigation of the effects of lead core heating and cumulative travel on the behavior of lead-rubber bearings. A literature review and an experimental study of the effects of temperature on the mechanical properties of lead are presented. A theory for predicting the temperature rise of the lead core in lead-rubber bearings subjected to lateral motion is developed based on principles of mechanics. The theory reduces the complex three dimensional thermo-mechanical problem into a numerically solvable initial value problem on the history of temperature of the core and the strength of the bearing. It is then used to establish principles of similarity and scaling that can be used in reduced scale testing of lead-rubber bearings. Studies on the dynamic response of seismically isolated structures using the proposed model demonstrate the importance of accounting for the effects of lead core heating in calculating the peak seismic response of seismically isolated structures.

Experimental and Analytical Investigation of Blast Performance of Seismically Resistant Bridge Piers

By Shuichi Fujikura and Michel Bruneau, MCEER-08-0028 December 8, 2008, 342 pages, $35.00

This report focuses on the protection of highway bridges against earthquake and blast hazards. The results of a previously developed and experimentally validated multi-hazard bridge pier concept consisting of a multi-column pier bent with Concrete-Filled Steel Tube (CFST) columns are briefly presented (see MCEER-07-0005). The performance of the CFST columns is compared to the blast resistance of ductile reinforced concrete (RC) columns and non-ductile RC columns retrofitted with steel jackets, detailed in accordance to current seismic design codes and practices. This report describes the details of the design process and the experimental observations of the prototype bridge pier bent constructed using conventional and retrofitted seismic resistant RC columns. The results from blast experiments are compared with results obtained using simplified analysis methods. Nonlinear dynamic response history analyses are performed to simulate and better understand the behavior of CFST columns under blast loading. The tests on conventional and steel jacket retrofitted seismic resistant RC columns demonstrated the non-ductile behavior of the RC columns under blast loading and that the columns failed in direct shear at their base. Based on experimental and analytical observations, shape factors for the blast pressures acting on circular columns are established.

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Upcoming Events

Seventh International Workshop on Remote Sensing for Disaster Management

October 22-23, 2009 | Austin, Texas

This workshop is the latest in a series that brings together remote sensing analysts, disaster researchers, and emergency managers to exchange ideas and research results related to the use of remote sensing in disaster management. This year's event will focus on *Remote Sensing for the Disaster Cycle: Preparedness, Response, and Recovery.* Contact Prof. Ellen Rathje, *e.rathje@mail.utexas.edu*, for more information.

ATC & SEI Conference on Improving the Seismic Performance of Existing Buildings and Other Structures

December 9-11, 2009 | San Francisco, California

Organized by the Applied Technology Council and the Structural Engineering Institute of ASCE, this event will focus on the seismic evaluation & rehabilitation of existing buildings. For more information, see page 4 or visit *http://www.atc-sei.org/index.html*.

Ninth U.S. National and Tenth Canadian Conference on Earthquake Engineering: Reaching Beyond Borders

July 25-29, 2010 | Toronto, Canada

This conference will provide an opportunity for researchers and practitioners to share the latest knowledge and techniques for understanding and mitigating the effects of earthquakes. It is the first time that a conference of this scale is jointly organized by EERI and the Canadian Association for Earthquake Engineering. MCEER Director Andre Filiatrault is the conference co-chair, and Donald Goralski and Gilberto Mosqueda are part of the organizing committee. More information is available at: *http://www.2010eqconf.org*.

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MCEER
University at Buffalo, The State University of New York
133A Ketter Hall
Buffalo, NY 14261

Phone: (716) 645-3391
Fax: (716) 645-3399
E-mail: *mceer@mceermail.buffalo.edu*

Website: *http://mceer.buffalo.edu*

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Staff

Editor: Jane Stoyle

Illustration/Photography: David Pierro

Layout/Composition: Michelle Zuppa

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